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METEOROLOGICAL OFFICE

PROFESSIONAL NOTES No. 70

*(Tenth Number of Volume V)*

# OBSERVATIONS OF THE BLUENESS OF THE SKY

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1936

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# OBSERVATIONS OF THE BLUENESS OF THE SKY

By J. S. FARQUHARSON, M.A.

In the *Meteorologische Zeitschrift* for 1928, Ostwald and Linke(1)* gave a description of a scale and of the method of using it for making observations of the blueness of the sky. The scale consisted of seven cards in graded tints of blue, the tints being made up of a mixture of white and ultramarine in the proportion of white to blue as follows :— 0·56, 0·35, 0·22, 0·14, 0·089, 0·056, and 0·035. The technical evolution of this scale is fully described by Ostwald. The palest tint was called 2 on the scale and the deepest 14. An observation was made by comparing that part of the sky at 60° to 90° from the sun, in the sun's azimuth, with the appropriate card held so as to be illuminated by the sun. Linke emphasised the necessity for practice and care in making the observation and later writers on the use of the scale, Losznitzer(2), Voigts(3) and Grimm(4), also suggested that considerable practice was needed for its correct use. Odd numbers were interpolated in the scale to indicate intermediate tints and zero implied an absolutely white sky.

Earlier, at the end of 1925, Linke had approached a large number of meteorological institutes with the request that this scale might be used experimentally so that comparable observations might be obtained at many differently situated places. The Meteorological Office was among those approached and observations were begun in June, 1926, at Cattewater (Plymouth), Cranwell and Croydon. The observations were made, as nearly as possible, at 0800, 1200 and 1600 G.M.T. at Croydon and Cattewater and at 0900, 1200 and 1600 G.M.T. at Cranwell. They were maintained up to December, 1928, at the former two stations and up to December, 1930, at Cranwell. The total number of observations was 2,632 at Croydon, 2742 at Cattewater and 4318 at Cranwell.

In his letter requesting the observations to be made, Linke stated : " Many years of observation have shown that the degree of obscurity of the atmosphere is closely associated with the blueness of the sky . . .". This association features prominently in all published notes on the results of these observations. Linke himself, from a series of observations in the Argentine(5) in 1923, deduced the relation $B = 12{\cdot}0 - 14{\cdot}5 \log T$, where $B$ is the blueness of the sky as measured on the scale described, and $T$ the turbidity factor, one definition of which is, that it is the number of clean dry atmospheres which would diminish the direct solar radiation intensity by the same amount as does the single, moist, polluted atmosphere. In view of the conflicting results of the attempts to relate the blueness of the sky to the degree of atmospheric obscurity, it should be noted, in connexion with this formula, that, according to Linke(6), $T$ has no physical significance in the neighbourhood of large cities, under a height of 200m. Hand(7) found at the Solar Observatory, Washington, that there was a progressive increase in visibility from an average of 14·9 miles for shade 4 to an average of 50 miles for shade 8,

* The numbers in brackets refer to the list of references on p. 9.

no shade paler than 4 or deeper than 8 having been observed. It often happened, however, that the visibility was relatively poor with a deep blue sky. The relationship between the blueness of the sky and the number of dust particles per cubic centimetre was irregular until a number of observations made in easterly winds was eliminated, when this relationship became quite close. At Apia, Samoa, Thomson(8) found that there was a progressive decrease in average visibility from shade 4 to shade 9. Loewe(9), making a series of observations by means of an aeroplane on 102 days between April, 1926, and April, 1927, in Berlin, showed that the blueness of the sky from the ground, the visibility of the ground from a height of 3 Km., and its variation were all dependent on what happened in the lowest kilometre. He found also that the average shade of blue increases with height up to 6 Km., the greatest increase occurring between the value at the ground and that at 1 Km., especially in the winter half-year from October to March.

For the first six months during which Linke's scale was used at the three English stations, observations of visibility were made simultaneously with those of the blue of the sky, to find out what connexion, if any, existed between the two. On examination at the end of this period, the observations showed that the connexion between ground horizontal visibility and blueness of the sky was very slight. Speaking broadly, the higher numbers of the scale were never observed with poor visibility and the average value of the shade of blue was found to increase with visibility but the scatter of the observations was so great that the average by itself did not properly interpret them. One could get a low number on the scale with good visibility.

The highly subjective nature of the observation made by the use of the Linke scale was commented upon by many of those who used it. In this connexion Losznitzer(2) suggested a device for improving the observation while Kuhl(10) described an instrument for making it objectively. At Cattewater, Cranwell and Croydon, the personal equation of the observer was also found to be one of the most important factors governing the observations. Two observers, making an observation at the same time, might differ as to the shade of the blue of the sky by as much as three on the scale. Further, observers, particularly at Cattewater, appear to have found it too difficult to use the odd numbers on the scale ; and considering the difficulty of making the observation even with the appropriate card held in front of the eyes, this is not surprising. This distaste for, or difficulty in, using the odd numbers is apparent in the very sharp alternations in frequency between odd and even shades, particularly for shades 10 to 12 inclusive at Cattewater (Table I). Lettau(11) draws attention to a personal tendency of opposite kind in the observations at Königsberg. There, the observer favoured the odd shades on the scale so that the lowness of the frequency of shade 8 as compared with shades 7 and 9 was obviously due to the personal

TABLE I.—CATTEWATER, PERCENTAGE FREQUENCIES AT ALL HOURS OF OBSERVATIONS

| Scale | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 .. | 30·1 | 29·8 | 21·0 | 17·2 | 11·3 | 17·8 | 18·6 | 17·2 | 18·9 | 23·9 | 25·6 | 34·0 | 22·2 |
| 1 .. | 1·0 | 1·2 | 0·5 | — | 0·5 | 0·6 | 1·8 | 0·4 | 1·9 | 0·7 | 1·1 | 1·8 | 1·0 |
| 2 .. | 0·5 | — | 1·0 | 2·8 | 2·1 | 2·2 | 1·8 | 2·1 | 2·6 | 3·3 | 1·1 | 3·2 | 2·0 |
| 3 .. | — | 2·9 | 3·8 | 1·0 | 4·8 | 2·8 | 4·3 | 2·5 | 8·2 | 2·2 | 1·9 | 3·9 | 3·3 |
| 4 .. | 3·8 | 3·5 | 1·6 | 3·3 | 4·8 | 5·0 | 6·5 | 7·9 | 5·2 | 4·7 | 4·1 | 5·4 | 4·8 |
| 5 .. | 1·0 | 5·3 | 4·3 | 6·1 | 11·3 | 6·7 | 6·8 | 6·8 | 6·7 | 8·7 | 5·9 | 10·4 | 6·9 |
| 6 .. | 7·5 | 7·0 | 5·4 | 6·1 | 8·1 | 2·8 | 9·7 | 7·5 | 8·5 | 8·7 | 11·1 | 10·0 | 8·0 |
| 7 .. | 7·5 | 6·4 | 3·8 | 5·5 | 5·4 | 4·4 | 6·8 | 3·6 | 5·9 | 4·0 | 4·4 | 4·7 | 5·1 |
| 8 .. | 5·4 | 5·7 | 5·9 | 6·1 | 6·5 | 6·7 | 9·7 | 9·0 | 7·0 | 7·6 | 9·3 | 8·2 | 7·9 |
| 9 .. | 4·8 | 7·6 | 2·7 | 8·9 | 5·4 | 8·9 | 6·8 | 3·9 | 5·6 | 3·6 | 3·3 | 3·6 | 5·2 |
| 10 .. | 14·0 | 12·3 | 10·2 | 12·2 | 14·0 | 9·4 | 9·0 | 10·7 | 6·7 | 8·3 | 11·1 | 6·8 | 10·1 |
| 11 .. | 2·7 | 2·9 | 3·8 | 5·5 | 4·3 | 3·9 | 2·5 | 2·1 | 1·1 | 3·3 | 1·9 | 1·4 | 2·8 |
| 12 .. | 14·0 | 9·4 | 19·3 | 14·4 | 11·3 | 16·1 | 8·2 | 11·1 | 10·0 | 10·9 | 8·9 | 5·0 | 11·1 |
| 13 .. | 2·2 | 1·2 | 4·8 | 3·3 | 3·2 | 11·1 | 2·9 | 3·9 | 4·1 | 4·0 | 3·7 | 1·1 | 3·0 |
| 14 .. | 5·4 | 4·7 | 11·8 | 7·2 | 7·0 | 11·7 | 4·7 | 11·1 | 7·4 | 6·2 | 6·7 | 0·4 | 6·8 |
| Number of observations.. | 186 | 171 | 186 | 180 | 186 | 180 | 279 | 274 | 270 | 276 | 270 | 279 | 2,742 |

error. On the Sonnblick, Lauscher(12) states that odd shades occurred only rarely, so rarely, in fact, that for statistical purposes they were equally divided between the even shades on either side. If, at Cattewater, the frequencies for shade 1 are all given to shade 2 and those for the other odd shades are equally divided between the even shades on either side then the percentage frequencies are as given in Table II, in which reference to zero is omitted. The sharp alternations are smoothed out; the maximum annual frequency is 14·1 per cent for shade 10, but shades 6 and 12 are very close to it, each having a frequency of 14·0 per cent. If the observations of the odd shades and of zero are entirely neglected and the frequencies expressed as a percentage of the total remaining number of observations then the maximum annual frequency is 22·0 per cent for shade

TABLE II.—CATTEWATER, PERCENTAGE FREQUENCIES AFTER FREQUENCIES FOR ODD SCALE NUMBERS HAVE BEEN DIVIDED BETWEEN EVEN NUMBERS ON EITHER SIDE, THE FREQUENCIES FOR "1" BEING ALL GIVEN TO "2" AND OMITTING REFERENCE TO "0".

| Scale | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 .. | 1·6 | 2·6 | 3·5 | 3·3 | 5·1 | 4·2 | 5·7 | 3·8 | 8·5 | 5·1 | 3·1 | 7·0 | 4·7 |
| 4 .. | 4·3 | 7·6 | 5·6 | 6·9 | 12·5 | 9·7 | 12·0 | 12·6 | 12·6 | 10·2 | 7·9 | 12·3 | 9·9 |
| 6 .. | 11·8 | 12·9 | 9·4 | 11·9 | 16·4 | 8·3 | 16·4 | 12·7 | 14·8 | 15·0 | 16·3 | 17·6 | 14·0 |
| 8 .. | 11·5 | 12·9 | 9·2 | 13·3 | 11·8 | 13·4 | 16·4 | 12·7 | 12·8 | 11·4 | 13·1 | 12·4 | 12·7 |
| 10 .. | 17·8 | 17·6 | 13·4 | 19·4 | 18·8 | 15·8 | 13·8 | 13·8 | 10·0 | 11·8 | 13·7 | 9·3 | 14·1 |
| 12 .. | 16·2 | 11·4 | 23·9 | 18·9 | 15·0 | 18·6 | 11·0 | 14·2 | 13·0 | 14·5 | 11·6 | 6·3 | 14·0 |
| 14 .. | 6·5 | 5·3 | 14·1 | 8·9 | 8·6 | 12·2 | 6·1 | 13·1 | 9·5 | 8·2 | 8·5 | 0·9 | 8·3 |

12, next being 20·0 per cent for shade 10 and 15·9 per cent for shade 6. From both Tables I and II it may be seen that, for the year, apart from the odd shades, the curve of increasing frequency from shade 2 to shade 12 gives a slight dip down at shade 8.

Tables III and IV give percentage frequencies of the shades of blue at Croydon and Cranwell respectively. It should be noted that an absolutely white sky was never observed at any of the three stations and the zero of the scale was used to denote an overcast sky. The alternations between odd and even shades, noted at Cattewater, do not show up well in the annual figures at Cranwell and Croydon but there is some suggestion of them in the individual months.

TABLE III.—CROYDON, PERCENTAGE FREQUENCIES AT ALL HOURS OF OBSERVATION

| Scale | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 .. | 48·7 | 47·4 | 36·8 | 32·8 | 23·5 | 24·4 | 27·2 | 19·8 | 29·6 | 36·5 | 51·7 | 55·1 | 35·5 |
| 1 .. | 2·7 | — | 0·5 | — | — | 0·9 | 0·7 | — | 0·8 | 2·1 | 0·4 | 4·0 | 1·0 |
| 2 .. | 1·6 | 3·5 | 2·2 | 1·1 | 1·6 | 1·8 | 2·2 | 2·2 | 0·8 | 0·8 | 1·7 | 5·3 | 2·0 |
| 3 .. | 4·9 | 5·3 | 1·6 | 1·1 | 3·3 | 3·2 | 4·0 | 3·7 | 2·3 | 2·1 | 5·1 | 5·8 | 3·5 |
| 4 .. | 8·1 | 6·4 | 9·7 | 5·0 | 9·3 | 5·5 | 4·7 | 7·0 | 9·7 | 8·6 | 5·1 | 6·2 | 7·1 |
| 5 .. | 12·4 | 9·9 | 5·9 | 14·4 | 8·7 | 8·3 | 9·1 | 6·3 | 10·1 | 11·1 | 8·1 | 9·3 | 9·3 |
| 6 .. | 15·1 | 14·0 | 12·4 | 17·2 | 25·7 | 13·4 | 17·7 | 20·2 | 19·8 | 14·8 | 17·4 | 9·3 | 16·5 |
| 7 .. | 4·9 | 8·2 | 10·7 | 11·1 | 14·2 | 20·3 | 13·0 | 14·3 | 10·9 | 12·7 | 6·8 | 4·0 | 11·1 |
| 8 .. | 1·6 | 4·7 | 16·7 | 12·2 | 10·9 | 15·2 | 14·9 | 23·9 | 14·4 | 10·7 | 3·8 | 0·9 | 11·3 |
| 9 .. | — | 0·6 | 2·7 | 4·4 | 2·2 | 3·2 | 4·7 | 1·5 | 0·8 | 0·8 | — | — | 1·7 |
| 10 .. | — | — | 1·1 | 0·6 | 0·5 | 2·3 | 1·5 | 0·7 | 0·8 | — | — | — | 0·6 |
| 11 .. | — | — | — | — | — | 1·4 | 0·4 | 0·4 | — | — | — | — | 0·2 |
| Number of observations.. | 185 | 171 | 186 | 180 | 183 | 217 | 276 | 272 | 257 | 244 | 236 | 225 | 2,632 |

Shades 12, 13, 14 on the scale were not observed at any time.

TABLE IV.—CRANWELL, PERCENTAGE FREQUENCIES AT ALL HOURS OF OBSERVATION

| Scale | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 .. | 49·7 | 54·7 | 42·5 | 46·2 | 45·8 | 37·2 | 36·4 | 36·3 | 41·2 | 40·2 | 49·0 | 57·3 | 44·3 |
| 1 .. | — | 0·3 | — | — | 0·3 | 0·5 | 0·2 | — | — | 0·3 | — | — | 0·1 |
| 2 .. | 2·4 | 1·0 | 1·5 | — | 0·3 | 0·8 | 1·2 | 0·5 | 0·5 | — | 0·5 | — | 0·7 |
| 3 .. | 2·1 | 2·0 | 1·2 | 1·0 | 0·6 | 1·6 | 2·2 | 0·8 | 0·3 | 0·5 | 1·0 | 1·4 | 1·2 |
| 4 .. | 6·7 | 4·6 | 3·6 | 4·3 | 2·4 | 2·9 | 3·9 | 1·3 | 2·0 | 3·0 | 3·8 | 4·6 | 3·5 |
| 5 .. | 4·6 | 5·9 | 5·8 | 4·0 | 4·2 | 5·1 | 4·1 | 2·6 | 7·1 | 4·5 | 7·3 | 6·6 | 5·1 |
| 6 .. | 16·2 | 10·5 | 11·2 | 8·6 | 11·4 | 14·2 | 17·2 | 19·7 | 21·7 | 14·3 | 15·6 | 11·2 | 14·6 |
| 7 .. | 9·8 | 8·2 | 14·9 | 10·2 | 13·2 | 11·0 | 11·4 | 13·8 | 8·6 | 14·3 | 8·8 | 14·6 | 11·6 |
| 8 .. | 6·7 | 9·5 | 13·9 | 18·8 | 15·0 | 18·7 | 16·7 | 17·6 | 14·4 | 19·4 | 13·1 | 4·0 | 14·2 |
| 9 .. | 1·8 | 2·6 | 2·7 | 4·3 | 4·5 | 6·7 | 5·1 | 4·6 | 2·0 | 2·3 | 1·0 | 0·3 | 3·2 |
| 10 .. | — | 0·7 | 2·4 | 1·7 | 2·1 | 1·3 | 1·5 | 2·6 | 2·0 | 0·5 | — | — | 1·2 |
| 11 .. | — | — | 0·3 | 0·7 | 0·3 | — | — | 0·3 | 0·3 | 0·8 | — | — | 0·2 |
| 12 .. | — | — | — | 0·3 | — | — | — | — | — | — | — | — | 0·02 |
| Number of observations.. | 328 | 305 | 330 | 303 | 334 | 374 | 412 | 391 | 396 | 398 | 398 | 349 | 4,318 |

Shades 13 and 14 on the scale were not observed at any time.

The most striking thing about the tables is that though shade 14 was quite frequently observed at Cattewater, no shade above 12 was observed at Cranwell and no shade above 11 at Croydon. In this respect, the latter two stations were more like the majority of those in other parts of the world. At Königsberg, Lübeck and Apia, the highest shade observed was 12, at Tabarz (Thuringia) it was 10 and at Washington, 8. Even at the high-level station of La Quiaca (3,600 m.) in Bolivia, Linke(5) observed during his Argentine (1923) series of observations that the deepest shade of blue was only 12. On the Sonnblick (3,106 m.), however, shade 14 was found to occur frequently. Another noteworthy feature of the English observations is that while the maximum frequencies are in shades 10 and 12 at Cattewater, they occur in shades 6, 7 and 8 at Cranwell and Croydon. The thought at once occurs that these differences are probably due to differences in the intensity of atmospheric pollution. Of the three places, Croydon should be the most affected by industrial atmospheric pollution and Cattewater least. Cranwell, though strictly rural, nevertheless is within easy reach of the industrial atmospheric pollution of the Midlands. Table V shows percentage frequencies of winds from various directions for the period June, 1926, to December, 1928, inclusive, the wind observations used being those made at 0700, 1300 and 1800 G.M.T. At all three stations the prevailing wind was south-westerly though the frequencies for SW. and W. winds were less at Cattewater than at either Cranwell or Croydon.

TABLE V.—WINDS, PERCENTAGE FREQUENCIES JUNE, 1926, TO DECEMBER, 1928

| — | Calm | N. | NE. | E. | SE. | S. | SW. | W. | NW. |
|---|---|---|---|---|---|---|---|---|---|
| Cranwell .. .. | 3·5 | 8·0 | 8·0 | 8·2 | 8·4 | 11·1 | 21·2 | 21·0 | 10·6 |
| Croydon .. .. | 4·3 | 6·8 | 10·8 | 7·1 | 5·4 | 9·3 | 24·9 | 19·9 | 11·4 |
| Cattewater .. .. | 4·9 | 10·1 | 7·7 | 11·3 | 6·7 | 11·6 | 19·1 | 15·1 | 13·5 |

It is noteworthy that Cranwell is intermediate between Cattewater and Croydon as regards the frequency of the shades of blue above 8. On the other hand, while the percentage annual frequencies at Croydon and Cattewater of shades below 4 are similar, those for Cranwell are much lower. Against the inference that the agency controlling the paler skies at Cattewater and Croydon is the same, it should be noted that at these two places the monthly frequencies of shades below 4 show little resemblance. At Croydon, the sum of the frequencies of shades 1, 2 and 3 is a maximum in December, while at Cattewater the maximum occurs in September. The minimum of this sum occurs in April at Croydon and in January at Cattewater. Linke(5) and Thomson(8) have suggested that their observations in the Argentine and at Apia indicate a connexion

between the blueness of the sky and hygroscopic nuclei while Loewe(9) and Hand(7) show that a high vapour pressure is associated with a sky of paler blue than a low vapour pressure. The observations at Cattewater do not confirm these relationships. With prevailing south-westerly winds it seems unlikely that Cattewater was freer from hygroscopic nuclei than Cranwell or Croydon, while the summaries of vapour pressure for the years 1927 and 1928 and for the months June to December, 1926, show that at 0700, 1300 and 1800 G.M.T. the values at Cattewater were invariably in excess of those at either Cranwell or Croydon. Eredia(13) also found no obvious connexion between the blueness of the sky and vapour pressure, on several occasions when he made a series of hourly observations during the prevalence of the tramontana in Rome, in December, 1928, and January, 1929.

The frequency table for Croydon shows a striking annual variation, the highest shade observed occurring in the three summer months. Shades above 8 were never observed in November, December or January. Frequencies of shades above 6 increase to a maximum in summer and, correspondingly, for shades below 4 they increase to a maximum in winter. There is evidence of a similar variation at Cranwell but not at Cattewater. The annual variation also shows up in the average values given in Table VI.

TABLE VI.—AVERAGE VALUES OF THE SHADE OF BLUE OF THE SKY ON THE LINKE SCALE

| Time of Obs. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Croydon: | | | | | | | | | | | | | |
| 0800.. | 4·5 | 5·0 | 5·8 | 6·1 | 5·8 | 6·7 | 6·1 | 6·2 | 5·9 | 5·5 | 5·1 | 3·6 | 5·6 |
| 1200.. | 5·8 | 5·7 | 6·6 | 6·3 | 6·2 | 6·6 | 6·1 | 6·4 | 6·3 | 6·2 | 6·2 | 5·3 | 6·2 |
| 1600.. | 4·5 | 5·3 | 6·3 | 6·5 | 6·1 | 6·1 | 6·7 | 6·5 | 6·1 | 5·7 | 5·0 | 3·8 | 6·0 |
| All .. | 4·9 | 5·4 | 6·2 | 6·3 | 6·0 | 6·5 | 6·2 | 6·4 | 6·0 | 5·8 | 5·4 | 4·3 | 5·9 |
| Catte-water: | | | | | | | | | | | | | |
| 0800.. | 9·2 | 7·4 | 9·2 | 8·5 | 8·2 | 8·9 | 7·5 | 8·2 | 6·8 | 7·3 | 7·9 | 6·3 | 7·8 |
| 1200.. | 9·4 | 9·1 | 10·1 | 9·2 | 8·1 | 9·1 | 7·9 | 9·1 | 8·6 | 8·9 | 9·2 | 7·5 | 8·8 |
| 1600.. | 9·1 | 9·2 | 10·1 | 9·8 | 8·9 | 9·6 | 8·2 | 9·0 | 8·5 | 9·0 | 8·5 | 6·5 | 8·8 |
| All .. | 9·3 | 8·4 | 9·8 | 9·2 | 8·4 | 9·2 | 7·9 | 8·8 | 7·9 | 8·4 | 8·5 | 6·8 | 8·5 |
| Cranwell: | | | | | | | | | | | | | |
| 0900.. | 5·8 | 6·2 | 6·8 | 6·7 | 6·9 | 6·7 | 6·4 | 6·9 | 6·5 | 6·8 | 6·2 | 6·0 | 6·5 |
| 1200.. | 6·4 | 6·3 | 6·9 | 7·1 | 7·2 | 7·0 | 6·8 | 7·1 | 7·0 | 7·1 | 6·7 | 6·4 | 6·9 |
| 1600.. | 5·3 | 6·2 | 6·3 | 7·4 | 6·8 | 6·8 | 6·8 | 7·0 | 6·6 | 6·8 | 6·0 | 5·7 | 6·6 |
| All .. | 5·9 | 6·2 | 6·7 | 7·1 | 7·0 | 6·8 | 6·7 | 7·0 | 6·7 | 6·9 | 6·4 | 6·1 | 6·6 |

This table gives the average " blueness " at each of the hours of observation as well as for all hours and it reveals a marked diurnal variation, especially at Croydon where the differences noon values minus 0800 values decrease from a maximum in winter to a minimum in summer. In June, the average " blueness " is less at noon than at 0800 by a small margin. Linke suggested that convection should

cause midday values of the shade of blue of the sky to be less than those in the morning and at several places, including Apia, the Sonnblick and Lübeck, this apparently occurs in summer. The winter diurnal variation at these places appears roughly similar to that at Croydon, though at none of them is it so clearly shown. Apart from the month of January, the diurnal variation at Cattewater is roughly similar to that at Croydon, though the maximum differences, noon value minus 0800 value, occur in different months. At Cranwell, the average shade of blue at 0900 is lower than at noon, throughout the whole year, by amounts varying from 0·1 in February and March to 0·6 in January.

At all three English stations there appears to be a slight tendency for skies of deeper blue to occur in March and April than in February or May. A spring maximum in shade of blue has also been observed at Travemünde and Tabarz (Thuringia) but on the Sonnblick, March is a month of minimum average " blueness ".

On the assumption that the Cattewater observations are the more closely representative of conditions in an area without atmospheric pollution, then the pronounced nature of the maximum frequencies of shades 6 to 8 at Cranwell and Croydon may be explained by assuming that to the " normal " (unpolluted) frequencies of these shades is added a further sum due to the toning down of the deeper shades of blue by industrial atmospheric pollution. But for such atmospheric pollution, there would be a small maximum frequency spread over shades 8 to 12 inclusive and a gradual decrease in frequency to shade 4 on the one hand and to shade 14 on the other, the lower shades, 1, 2 and 3, being rare.

It appears fairly definite that there are two types of variation in the shade of blue of the sky, of which Croydon and Cattewater are typical examples.

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S.O. Code No. 40-99-99

(28494) Wt. 1928/1455 625 3/36 Hw. G.371